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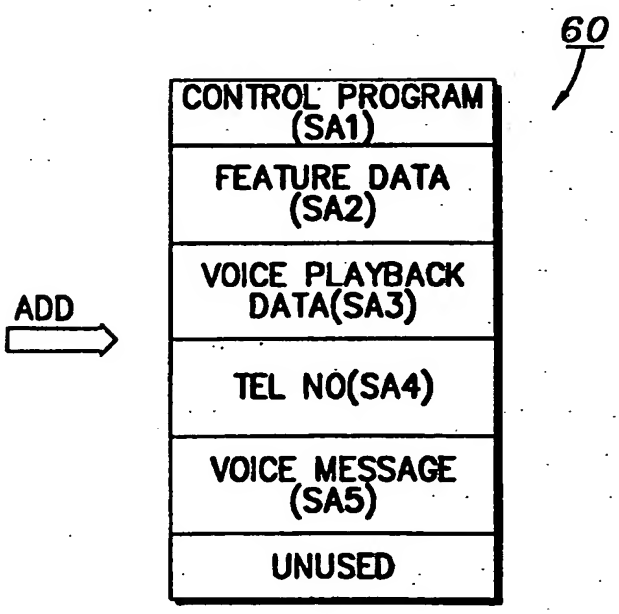
(54) Title: DIGITAL CELLULAR PHONE WITH VOICE RECOGNITION FUNCTION AND METHOD FOR CONTROLLING THE SAME

(57) Abstract

A digital cellular phone with a voice recognition function recognizes a voice signal using components included therein. A vocoder compresses a voice signal input from a microphone to output packet data. A nonvolatile memory stores the packet data and feature data corresponding thereto. A voice recognition device extracts the feature data from the packet data output from the vocoder, and compares the feature data with feature data registered in the nonvolatile memory to detect the registered feature data similar to the input feature data and a difference value therebetween to determine whether an input voice signal is recognized successfully depending on the difference value.



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DIGITAL CELLULAR PHONE WITH VOICE RECOGNITION FUNCTION AND METHOD FOR CONTROLLING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a digital cellular phone, and in particular, to a digital cellular phone having voice recognition capabilities and a method for controlling the same.

2. Description of the Related Art

In general, a voice recognition apparatus extracts features such as a frequency feature from an input voice signal to recognize the input voice. Such voice recognition apparatus requires significant processing power to process the large amount of voice signals. The amount of processing power needed would overload a typical digital cellular phone. Thus, the conventional voice recognition apparatus is unsuitable for a conventional digital cellular phone.

A known voice recognition method for solving the overload problem of the digital cellular phone utilizes a hands-free kit with the voice recognition function. The hands-free kit includes a digital signal processor (DSP) and a nonvolatile memory (e.g., flash memory or EEPROM (Electrically Erasable and Programmable Read Only

Memory)). The DSP in the hands-free kit processes compressed voice signal or original voice signal to recognize the input voice, and provides the recognized voice signal to the cellular phone. In this manner, the hands-free kit recognizes the voice for a telephone number uttered by the user, and
the cellular phone dials the telephone number according to the recognized voice signal provided from the hands-free kit.

FIG. 1 shows a block diagram of a conventional voice recognition apparatus which may be installed in the hands-free kit. As illustrated, an analog signal input from a microphone 30 is converted to a digital PCM(Pulse Code Modulation) signal by an analog-to-digital (A/D) converter 20, and provided to a processor 10 which performs the voice recognition function. The processor 10 may be realized by an 80186 chip or a DSP chip.

This conventional voice recognition apparatus has drawbacks which include: (1) significant processing demand, rendering it unsuitable for the digital cellular phone; (2) the processing requirement of the voice recognition apparatus poses a severe processing load on the cellular phone and may obstruct operation of the cellular phone; (3) the voice recognition apparatus requires a separate memory for the voice recognition function. Therefore, the hands-free kit requires a separate nonvolatile memory such as an EEPROM; (4) the voice recognition apparatus requires a separate processor such as a DSP for realizing the voice recognition function; and (5) if the voice recognition apparatus is installed in the hands-free kit, the voice recognition can be implemented through the hands-free kit only. Thus,

when separated from the hands-free kit, the cellular phone cannot recognize the voice.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a digital cellular phone with a voice recognition function, capable of recognizing a voice signal using hardware included therein, and a method for controlling the same.

To achieve the above object, the present invention provides a cellular phone with a voice recognition function having a vocoder for compressing a voice signal input from a microphone to output packet data. In the cellular phone, a nonvolatile memory stores the packet data and feature data corresponding thereto. A voice recognition device extracts the feature data from the packet data output from the vocoder, and compares the feature data with feature data registered in the nonvolatile memory to detect the registered feature data similar to the input feature data and a difference value therebetween. A microprocessor stores the packet data and the feature data in the nonvolatile memory in the voice registration mode, and receives an index for the similar feature data and a difference value from the voice recognition device in the voice recognition mode to determine whether an input voice signal is recognized successfully.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will become more apparent from

the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1 is a block diagram of a conventional voice recognition apparatus;

FIG. 2 is a block diagram of a digital cellular phone with a voice recognition function according to an embodiment of the present invention;

FIG. 3 is a diagram illustrating a memory map of a first memory (60) of FIG. 2; and

FIG. 4 is a flow chart for registering and recognizing a voice signal according to an embodiment of the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A preferred embodiment of the present invention will be described in detail hereinbelow with reference to the accompanying drawings. For comprehensive understanding of the present invention, the present invention will be illustratively described, confined to the specific embodiment.

It should be noted that the present invention can be implemented by anyone skilled in the art with the description. In the following description, well-known functions or constructions which may obscure the present invention in unnecessary detail are not described in detail. For example, FIG. 2 illustrates a digital cellular phone with a voice recognition function according to an embodiment of the present invention. An RF (Radio Frequency) circuit and a DTMF (Dual Tone Multi-Frequency) circuit could have been included in FIG. 2 but are not shown because they are not related to the gist of the present invention.

Referring to FIG. 2, an analog voice signal input from a microphone 30 is converted to a digital PCM signal by an A/D converter 20. A vocoder 45 compresses the PCM signal output from the A/D converter 20 and outputs packet data PKT. In a CDMA cellular phone, the vocoder 45 can be realized by an 8Kbps QCELP (Qualcomm Code Excited Linear Prediction) encoder, a 13Kbps QCELP encoder, or an 8Kbps EVRC (Enhanced Variable Rate Coding) encoder. In a GSM (Global System for Mobile Communications) cellular phone, the vocoder 45 can be realized by an RPE-LTP (Regular Pulse Excitation with Long Term Prediction) encoder.

The packet data PKT output from the vocoder 45 is applied to a microprocessor 50 which controls the overall operations of the cellular phone. A first memory 60 being a nonvolatile memory (e.g., a flash memory or EEPROM) stores data and software programs including a control program and initial service data. A second memory 65 is a RAM (Random Access Memory) for temporarily storing data including packet data for a voice signal to be registered or recognized and various data generated during operation of the cellular phone. A voice recognition device 85 extracts the feature data from the input voice signals and outputs the feature data, preferably at a transfer rate of several tens to several hundreds of bytes per second. The feature data includes the frequency feature and the intensity of the input voice signal. The voice recognition device 85 can be realized by either hardware or software. In case the voice recognition device 85 is realized by software, the software program for realizing the voice recognition device 85 can be stored in the first memory 60. The microprocessor 50 delivers the packet data PKT output from the vocoder 45 to the voice

recognition device 85. The voice recognition device generates and outputs the feature data to the microprocessor 50. The microprocessor 50 extracts the reference feature data previously registered or stored in the first memory 60 and compares them with the feature data from the voice recognition device 85. From the comparison, the microprocessor decides and dials the telephone number corresponding to the chosen reference feature data. Preferably, the decision of the comparison is based on a difference value between the two feature data. Further, the microprocessor 50 stores the packet data output from the vocoder 45 in a specific storage area of the first memory 60, and reads it from the first memory 60 when informing the user that the voice recognition is completed. For convenience, the read packet data is called the voice playback data VP. The vocoder 45 converts the voice playback data VP to a PCM signal and applies it to a digital-to-analog (D/A) converter 75, which converts the input PCM signal to an analog signal and outputs the converted analog signal to a speaker 80. Instead of the voice playback data VP, a voice message informing completion of the voice recognition may also be stored in the first memory 60. A hands-free kit connector 500 connects the hands-free kit to the cellular phone to transfer a voice signal input from a microphone of the hands-free kit to the vocoder 45 via the A/D converter 20. Further, when connected to the hands-free kit, the hands-free kit connector 500 cuts off a signal path between a microphone of the cellular phone and the vocoder 45.

FIG. 3 shows a memory map of the first memory 60 according to an embodiment of the present invention. As illustrated, the first memory 60 is divided into a first

storage area SA1 for the control program, a second storage area SA2 for the feature data, a third storage area SA3 for the voice playback data, a fourth storage area SA4 for the telephone number, and a fifth storage area SA5 for the voice message. A reference character ADD denotes an address signal input from the microprocessor 50.

FIG. 4 is a flow chart for registering and recognizing a voice signal according to an embodiment of the present invention. To dial a telephone number by voice, the user of the cellular phone will press a voice dialing key. Upon detection of key data for the voice dialing, the microprocessor 50 will enter a voice recognition mode in step 4a. After pressing the voice dialing key, the user will press a voice registration key to register a unregistered name in the first memory 60 or press a voice recognition key to dial by voice a telephone number for a registered name to whom he wants to call. Then, the microprocessor 50 determines in step 4b which of these keys the user has pressed. If the user has pressed the voice registration key, the microprocessor 50 checks in step 4c whether the valid packet data for the user's voice is input from the vocoder 45. If the valid packet data is input, the microprocessor 50 provides the input packet data to the voice recognition device 85 in step 4d, and stores the packet data in the third storage area SA3 of the first memory 60 as the voice playback data VP in step 4e. Thereafter, the microprocessor 50 checks in step 4f whether the feature data for the input voice is input from the voice recognition device 85. If the feature data is input, the microprocessor 50 stores the input feature data in the second storage area SA2 of the first memory

60. It is noted that the sequence of the steps 4e and 4f may be inverted or these two steps may be performed in parallel.

If the user has pressed the voice recognition key in the step 4b, the microprocessor 50 checks in step 4h whether the valid packet data for the user's voice is input from the vocoder 45. If the valid packet data is input, the microprocessor 50 provides the input packet data to the voice recognition device 85 in step 4i. After that, the microprocessor 50 checks in step 4j whether the feature data for the input voice is input from the voice recognition device 85. Upon receipt of the feature data, the microprocessor 50 temporarily stores it in the second memory 65. Further, in the step 4j, the microprocessor 50 checks whether an index for similar feature data and a difference value are input from the voice recognition device 85. Here, the index for the similar feature data refers to an index for the feature data registered in the first memory 60 which is similar to the feature data for the currently input voice, and the difference value refers to a difference value between the registered feature data and the feature data from the voice recognition device 85. Upon receipt of the index and the difference value, the microprocessor 50 checks in step 4k whether the difference value is smaller than a threshold value or a permissable error range. If the difference value is smaller than the threshold value, the microprocessor 50 outputs the voice playback data to the speaker 80 according to the index in step 4l, judging that the input voice is correctly recognized. However, if the difference value is equal to or greater than the threshold value, the microprocessor 50 reads from the fifth storage area SA5 of the first memory 60 a voice

message informing that the input voice is not registered in the cellular phone and provides the read voice message to the vocoder 45, in step 4m. Then, the voice message read from the first memory 60 is processed by the vocoder 45, converted to an analog signal by the D/A converter 75, and output to the speaker 80.

In addition, during the voice registration process, the corresponding telephone number is also registered in the fourth storage area SA4 of the first memory 60, so that the microprocessor 50 may read and dial the registered telephone number by means of the DTMF (not shown) circuit when the user inputs the registered voice.

Preferably, the voice recognition device 85 may extract two or more sets of the feature data for the same voice and store them in the second storage area SA2 of the first memory 60, so as to improve reliability of the voice recognition function.

As described above, the cellular phone of the invention uses the packet data output from the vocoder so that it can, with a simple operation, recognize the voice. Further, the cellular phone utilizes the built-in vocoder and memory for voice recognition. Advantageously, the cellular phone has integrated voice recognition capabilities which can be compactly built. The external hands-free kit may selectively be dispensed within.

While this invention has been described in connection with what is presently considered to be the most practical and preferred embodiment, it is to be understood that the invention is not limited to the

disclosed embodiment, but, on the contrary, it is intended to cover various modifications within the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. A digital cellular phone having a vocoder for compressing a voice signal inputted through a microphone, comprising:

first means for receiving packet data as an input from the vocoder and extracting feature data from the packet data; and

second means for registering the extracted feature data in a memory, comparing the registered feature data with feature data for an input voice signal, and recognizing the input voice signal if the registered feature data is similar to the feature data for the input voice signal.

2. The digital cellular phone as claimed in Claim 1, further comprising:

a nonvolatile memory for storing the packet data and the feature data corresponding to the packet data therein; and

a user interface unit for selecting a voice registration mode or a voice recognition mode.

3. The digital cellular phone as claimed in Claim 2, wherein the first means is a voice recognition device for comparing the extracted feature data with the registered feature data in the nonvolatile memory to detect the registered feature data similar to the extracted feature data and a difference value between the extracted feature data and the registered feature data.

4. The digital cellular phone as claimed in Claim 3, wherein the second means is a microprocessor for storing, in the nonvolatile memory, the packet data and

the feature data for the packet data in the voice registration mode, and receiving an index for the similar feature data and a difference value from the voice recognition device in the voice recognition mode to determine whether an input voice signal is recognized successfully.

5. The digital cellular phone as claimed in claim 2, further comprising a hands-free kit connector for transferring a voice signal input from a microphone of a hands-free kit to the vocoder, wherein when connected to the hands-free kit, the hands-free kit connector cuts off a signal path between a microphone of the cellular phone and the vocoder.

6. The digital cellular phone as claimed in claim 5, further comprising:

an analog-to-digital converter for converting the voice signal output from the microphone of the hands-free kit and the microphone of the cellular phone to a digital signal and outputting the converted digital signal to the vocoder; and

a digital-to-analog converter for converting a digital signal output from the vocoder to an analog signal and outputting the converted analog signal to a speaker.

7. The digital cellular phone as claimed in claim 4, wherein the nonvolatile memory stores telephone number data corresponding to the packet data for the input voice signal.

8. The digital cellular phone as claimed in claim 7, wherein the microprocessor controls to dial a telephone

number corresponding to the telephone number data, if the input voice signal is successfully recognized.

9. The digital cellular phone as claimed in claim 4, wherein the microprocessor reads voice playback data from the nonvolatile memory according to the index for the similar feature data and provides the read voice playback data to the vocoder to playback the input voice signal through a speaker.

10. The digital cellular phone as claimed in claim 4, wherein the microprocessor reads a voice message informing success or failure of the voice recognition from the nonvolatile memory and provides the read voice message to the vocoder so as to output the voice message through a speaker.

11. A voice recognition method in a digital cellular phone having a memory and a vocoder, comprising the steps of :

extracting feature data from packet data output from the vocoder;

registering the extracted feature data in the memory;

comparing the extracted feature data with the feature data previously registered in the memory, and then determining that the input voice signal is recognized successfully if the registered feature data is similar to the feature data for the input voice signal.

12. A method for controlling a cellular phone with a voice recognition function, comprising the steps of:

switching an operational mode of the cellular phone

to a voice recognition mode;

checking whether a user presses a voice registration key or a voice recognition key;

if the user presses the voice registration key, providing packet data for an input voice signal from a vocoder to a voice recognition device, storing voice playback data in a nonvolatile memory, and registering feature data for the packet data received from the voice recognition device in the nonvolatile memory; and

if the user presses the voice recognition key, providing the packet data for the input voice signal to the voice recognition device, extracting feature data for the packet data from the voice recognition device, reading registered feature data similar to the feature data for the packet data and a difference value therebetween from the nonvolatile memory, and determining whether or not the input voice signal is successfully recognized depending on the difference value.

13. The method as claimed in claim 12, further comprising the steps of:

registering a telephone number corresponding to the input voice signal in the nonvolatile memory in the registration mode; and

dialing the telephone number registered in the nonvolatile memory in the recognition mode, if the input voice signal is successfully recognized.

14. The method as claimed in claim 12, further comprising the step of switching the operational mode to an idle mode if the voice recognition is failed.

15. A cellular phone having a vocoder for compressing a voice signal input from a microphone

to output packet data and a microprocessor for controlling an operation of the cellular phone, comprising:

a nonvolatile memory for storing the packet data and feature data corresponding thereto;

a user interface unit with which a user chooses a voice registration mode and a voice recognition mode;

a voice recognition device for extracting the feature data from the packet data output from the vocoder in the voice registration mode or the voice recognition mode, and comparing the feature data with the registered feature data in the nonvolatile memory to detect the registered feature data similar to the extracted feature data and a difference value therebetween in the voice recognition mode; and

a microprocessor for storing the packet data and the feature data for the packet data in the nonvolatile memory in the voice registration mode, and receiving an index for the similar feature data and a difference value from the voice recognition device in the voice recognition mode to determine whether an input voice signal is recognized successfully.

16. The cellular phone as claimed in claim 15, wherein the microprocessor determines that the input voice signal is successfully recognized in the voice recognition mode if the difference value detected in the voice recognition device is lower than a critical value.

17. A cellular phone having a vocoder for compressing a voice signal input from a microphone to output packet data, comprising:

a nonvolatile memory for storing the packet data and feature data corresponding thereto;

a user interface unit with which a user chooses a voice registration mode and a voice recognition mode;

a voice recognition device for extracting the feature data from the packet data output from the vocoder in the voice registration mode or the voice recognition mode, and comparing the feature data with feature data registered in the nonvolatile memory to detect the registered feature data similar to the input feature data in the voice recognition mode; and

a microprocessor for storing the packet data and the feature data in the nonvolatile memory in the voice registration mode, and determining whether an input voice signal is recognized successfully or not depending on whether or not the similar feature data detected in the voice recognition device belongs to within a range of error.

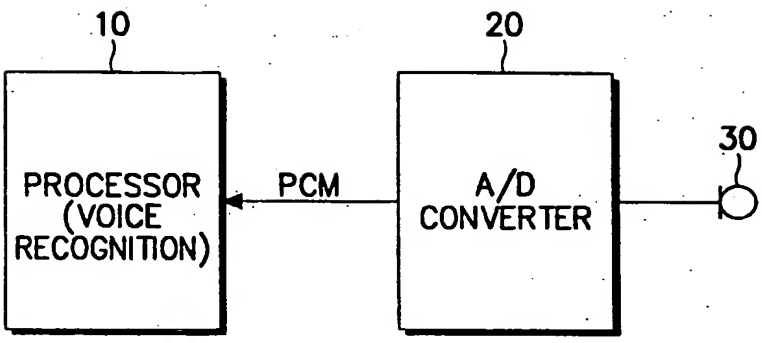
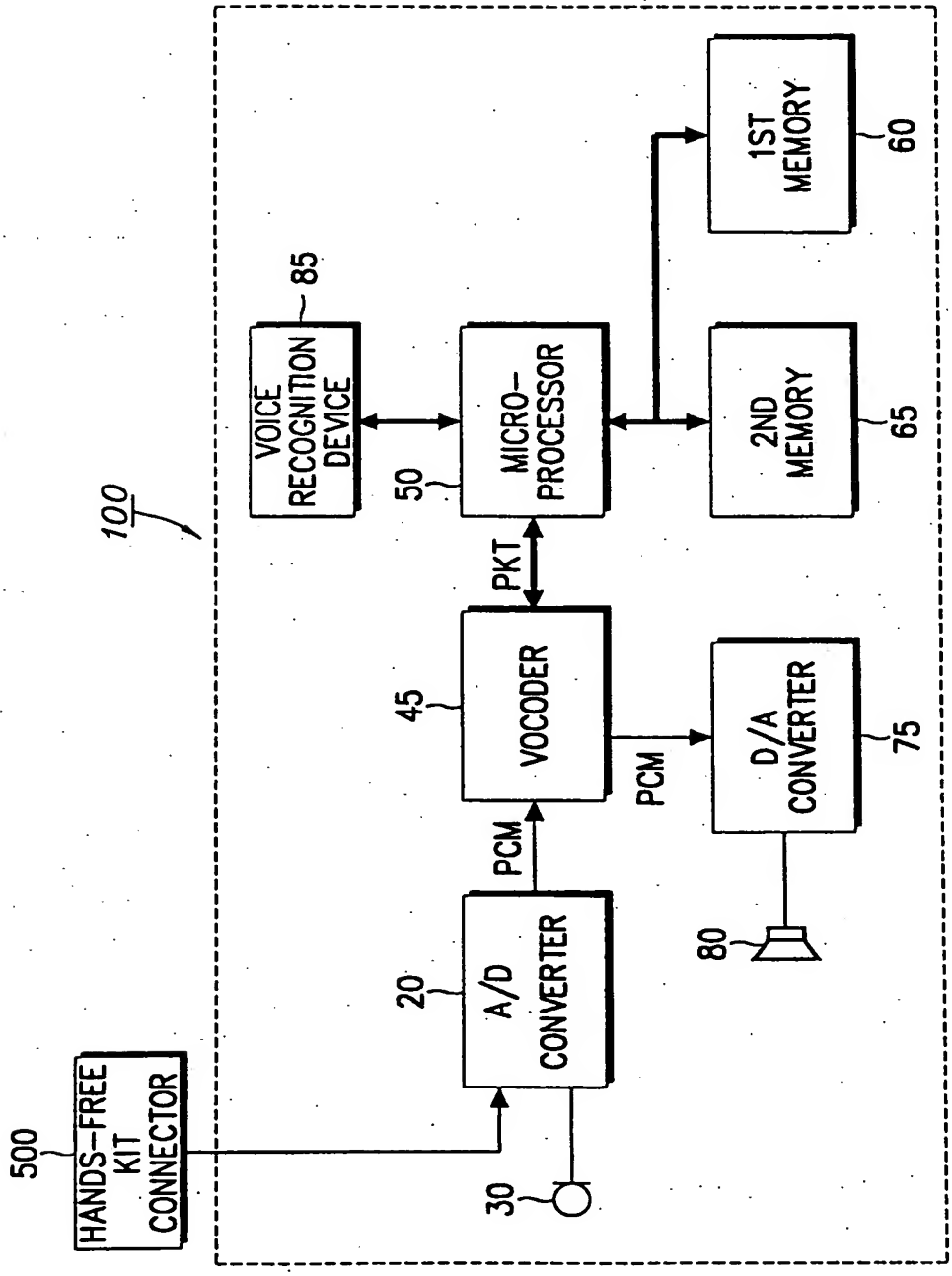


FIG. 1


100
HANDS-FREE KIT CONNECTOR
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A/D CONVERTER
20
PCM
VOCODER
45
PKT
MICRO-PROCESSOR
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VOICE RECOGNITION DEVICE
85
1ST MEMORY
60
2ND MEMORY
65
D/A CONVERTER
75
PCM
80
30

FIG. 2

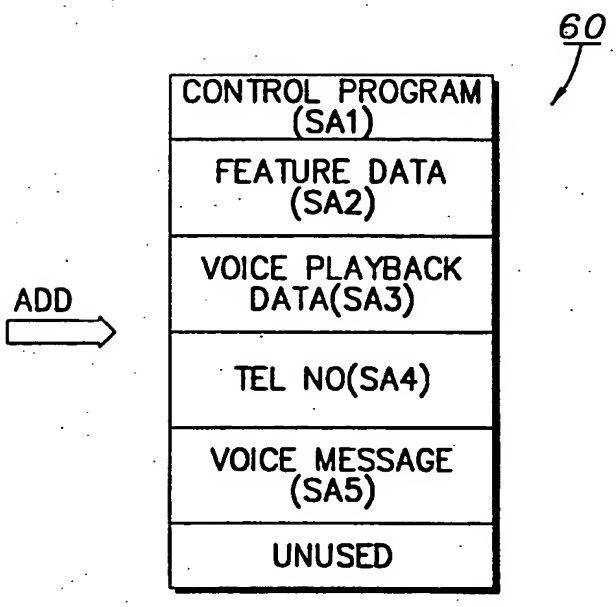
60
CONTROL PROGRAM (SA1)
FEATURE DATA (SA2)
VOICE PLAYBACK DATA(SA3)
TEL NO(SA4)
VOICE MESSAGE (SA5)
UNUSED
ADD

FIG. 3

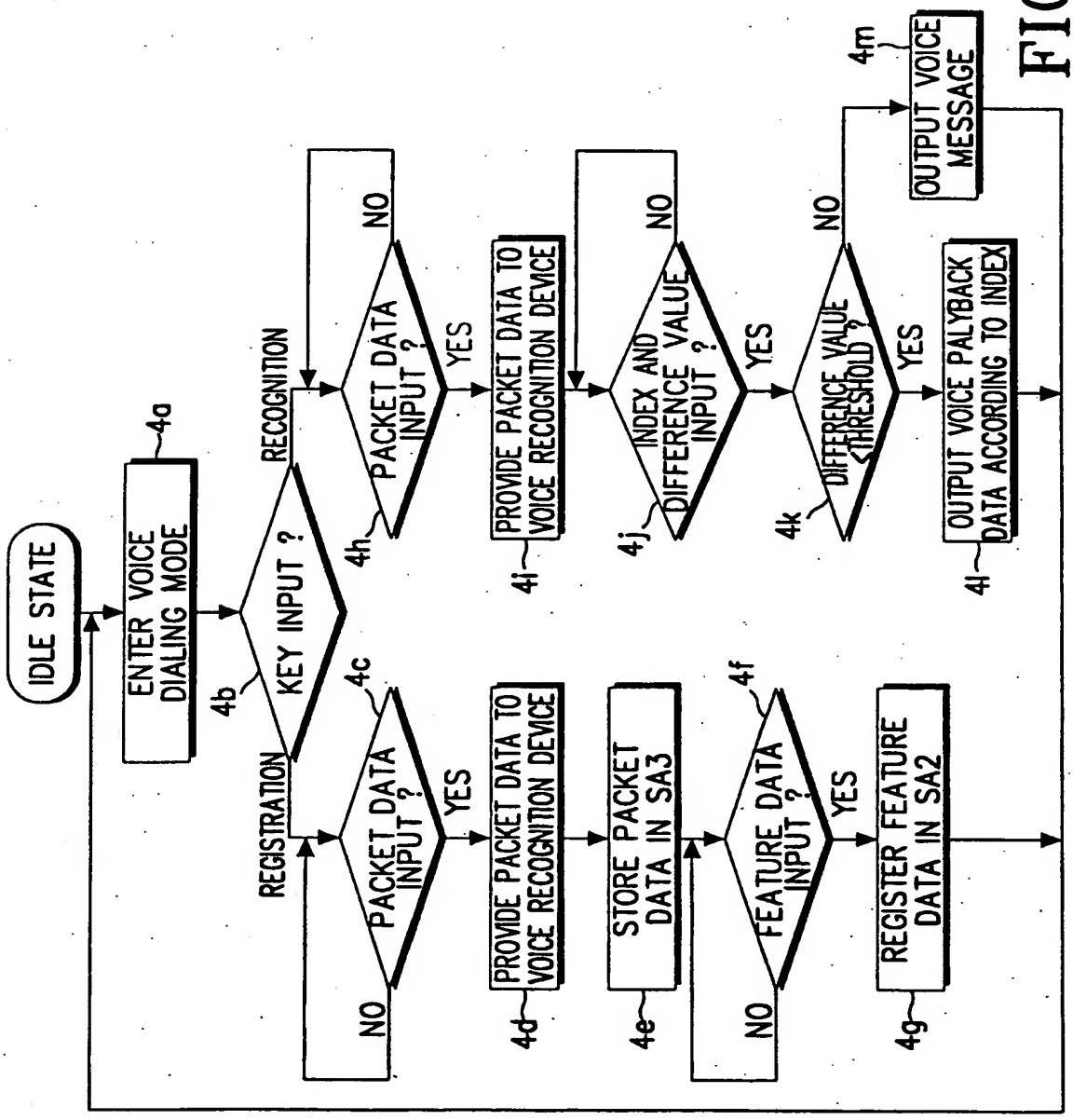
IDLE STATE
ENTER VOICE DIALING MODE
4a
KEY INPUT ?
4b
REGISTRATION
RECOGNITION
PACKET DATA INPUT ?
4c
NO
YES
PROVIDE PACKET DATA TO VOICE RECOGNITION DEVICE
4d
STORE PACKET DATA IN SA3
4e
FEATURE DATA INPUT ?
4f
NO
YES
REGISTER FEATURE DATA IN SA2
4g
PACKET DATA INPUT ?
4h
NO
YES
PROVIDE PACKET DATA TO VOICE RECOGNITION DEVICE
4i
INDEX AND DIFFERENCE VALUE INPUT ?
4j
NO
YES
DIFFERENCE VALUE <THRESHOLD ?
4k
NO
YES
OUTPUT VOICE PALYBACK DATA ACCORDING TO INDEX
4l
OUTPUT VOICE MESSAGE
4m

FIG. 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR 98/00195

A. CLASSIFICATION OF SUBJECT MATTER

IPC[6]: G 10 L 9/00,5/02; H 04 B 7/26; H 04 M 3/42,1/64

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B. FIELDS SEARCHED

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 97/12 361 A1 (AT & T CORP.) 03 April 1997 (03.04.97), abstract; fig.1,2; claims 1-18; page 3, lines 7-21.	1-17
A	US 5 450 525 A (RUSSELL et al.) 12 September 1995 (12.09.95), abstract; fig.1-3; claims 1,8; column 3, line 57 - column 4, line 28.	1-17
A	Database WPIL on Questel, week 9714, London: Derwent Publications Ltd., AN 97-152448, Class H 04 B, KR 9507091 B1 (LG COMMUNICATIONS CO., LTD.) 30 June 1995 (30.06.95), abstract.	1-17

[ ] Further documents are listed in the continuation of Box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
01 September 1998 (01.09.98)	08 September 1998 (08.09.98)

Name and mailing address of the ISA/	Authorized officer
Austrian Patent Office Kohlmarkt 8-10; A-1014 Vienna	Berger
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Form PCT/ISA/210 (second sheet) (July 1998)

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Information on patent family members

International application No.
PCT/KR 98/00195

Im Recherchenbericht angeführtes Patentdokument Patent document cited in search report Document de brevet cité dans le rapport de recherche	Datum der Veröffentlichung Publication date Date de publication	Mitglied(er) der Patentfamilie Patent family member(s) Membre(s) de la famille de brevets	Datum der Veröffentlichung Publication date Date de publication
WO A1 9712361	03-04-97	EP A1 795170	17-09-97
US A 5450525	12-09-95	keine - none - rien	